Princeton Plasma Physics Laboratory

NSTX Experimental Proposal

Title: **The k-space isotropy of ETG turbulence**		
OP-XP-	Revision:	Effective Date: *(Approval date unless otherwise stipulated)* Expiration Date: *(2 yrs. unless otherwise stipulated)*

PROPOSAL APPROVALS

Responsible Author: David Smith	Date July 29, 2009
ATI – ET Group Leader: Kevin Tritz (T&T)	Date
RLM - Run Coordinator: Roger Raman	Date
Responsible Division: Experimental Research Operations	

Chit Review Board (designated by Run Coordinator)

MINOR MODIFICATIONS (Approved by Experimental Research Operations)

NSTX EXPERIMENTAL PROPOSAL

TITLE: k-space isotropy of ETG turbulence No. **OP-XP-**
AUTHORS: David Smith DATE: 29 July 2009

1. Overview of planned experiment

Investigate the k-space isotropy of ETG turbulence using the NSTX collective scattering system.

2. Theoretical/ empirical justification

The isotropy of ETG turbulence in k-space is a topic of debate within the gyrokinetic community. Dorland, PRL, 2000; Jenko, PRL, 2002; and Nevins, PoP, 2006 predict ETG turbulence is anisotropic in the k_θ-k_r plane, but Waltz, PoP, 2007 and Candy, PoP, 2007 predict ETG turbulence is isotropic. Radial streamers are key to the isotropy debate. According to Dorland/Jenko/Nevins, ETG radial streamers generate the most severe ETG-driven electron thermal transport for magnetic shear above s-hat=0.5. Experimental data addressing the isotropy of ETG turbulence would be valuable to the gyrokinetic community.

Among toroidal confinement devices and fluctuation diagnostics worldwide, the NSTX collective scattering system is *uniquely* capable of investigating the k-space isotropy of ETG turbulence, and this XP describes an experimental plan to do so.

3. Experimental run plan

The steerable optics of the NSTX collective scattering system can alter the vertical location of the scattering volume, which alters the ratio k_θ/k_r of measured wave vectors. In other words, the vertical location of the scattering volume changes the location of fluctuation wave vectors in the k_θ-k_r plane. Ray tracing calculations provide measurement configurations with different k_θ/k_r radios.

With guidance from past scattering measurements, the baseline shot is 124889 (5.5 kG, 700 kA, H-mode deuterium discharge with 4 MW of NBI). The high-k system will measure fluctuations at R=133±2 cm and r/a=0.54.

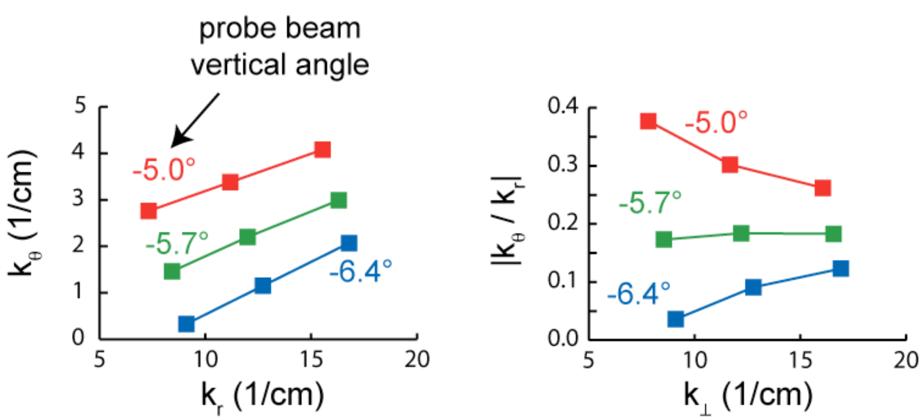
To investigate the role of magnetic shear in ETG isotropy, Ip ramp-downs will occur in some shots to transiently alter magnetic shear. To maintain NB confinement with Ip ramp-downs, the baseline plasma current will be 1 MA with ramp-downs to 800 kA.

The probe beam angle with respect to the X-axis will be 92.6° and the collection mirror angle with respect to the X-axis will be 230.5°. The table below gives the probe beam angle with respect to the Z-axis and exit window mirror angles for three scattering configurations, and the figure shows the k-space parameters.

Note that the scattering configurations below produce the largest k_θ/k_r variation in the low-k channel, and gyrokinetic simulations predict ETG anisotropy is strongest at low-k.

For statistics and reproducibility, obtain two baseline shots for each of the three configurations described below. Obtain additional shots (about 5) with a current ramp-down to transiently alter the magnetic shear in the outer plasma. This XP will need 1 run day.

PB Z ang	Channel	EW X ang	EW Z ang	k_θ	k_r	$k_\perp$	k_θ/k_r
95.0°	1	-0.3°	1.4°	4.08	-15.54	16.07	0.26
	2	-0.9°	1.2°	3.38	-11.18	11.68	0.30
	3	-1.0°	1.0°	2.76	-7.32	7.82	0.38
95.7°	1	0.0°	0.6°	2.99	-16.30	16.57	0.17
	2	-0.6°	0.4°	2.20	-12.00	12.20	0.18
	3	-0.6°	0.2°	1.30	-8.42	8.55	0.18
96.4°	1	0.1°	0.0°	2.07	-16.79	16.92	0.12
	2	-0.4°	-0.2°	1.15	-12.72	12.78	0.09
	3	-0.4°	-0.4°	0.33	-9.10	9.11	0.04



4. Required machine, NBI, RF, CHI and diagnostic capabilities

4 MW of NBI as per shot 124889; high-k scattering

5. Planned analysis

LRDFIT, TRANSP, GS2

6. Planned publication of results

Observations addressing the isotropy of ETG turbulence warrant a PRL.

PHYSICS OPERATIONS REQUEST

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(use additional sheets and attach waveform diagrams if necessary)

Describe briefly the most important plasma conditions required for the experiment:

MHD activity, if present, needs to be steady-state without bursting modes or fast-ion losses. In the baseline shot 124889, MHD activity was steady-state.

Previous shot(s) which can be repeated: 124889 (4 MW NBI, 700 kA Ip, 5.5 kG TF)

Previous shot(s) which can be modified:

Machine conditions *(specify ranges as appropriate, strike out inapplicable cases)*

I_{TF} (kA): standard 5.5 kG Flattop start/stop (s):

I_P (MA): 1.0 MA Flattop start/stop (s):

Configuration: **LSN**

Equilibrium Control: **Isoflux** (rtEFIT)

Outer gap (m): Inner gap (m): Z position (m):

Elongation κ: Upper/lower triangularity δ:

Gas Species: **D** Injector(s):

NBI Species: **D** Voltage (kV) **A:** **B:** **C:** Duration (s):

ICRF: Off

CHI: **Off**

LITERs: Off

EFC coils: Configuration: **Odd / Even / Other** *(attach detailed sheet*

DIAGNOSTIC CHECKLIST

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Note special diagnostic requirements in Sec. 4

Diagnostic	Need	Want
Bolometer – tangential array	√	
Bolometer – divertor	√	
CHERS – toroidal	√	
CHERS – poloidal	√	
Divertor fast camera		
Dust detector		
EBW radiometers		
Edge deposition monitors		
Edge neutral density diag.		
Edge pressure gauges		
Edge rotation diagnostic	√	
Fast ion D_alpha - FIDA	√	
Fast lost ion probes - IFLIP		
Fast lost ion probes - SFLIP		
Filterscopes		
FIReTIP	√	
Gas puff imaging		
Hα camera - 1D		
High-k scattering	√	
Infrared cameras		
Interferometer - 1 mm	√	
Langmuir probes – divertor		
Langmuir probes – BEaP		
Langmuir probes – RF ant.		
Magnetics – Diamagnetism	√	
Magnetics – Flux loops	√	
Magnetics – Locked modes	√	
Magnetics – Pickup coils	√	
Magnetics – Rogowski coils	√	
Magnetics – Halo currents	√	
Magnetics – RWM sensors	√	
Mirnov coils – high f.	√	
Mirnov coils – poloidal array	√	
Mirnov coils – toroidal array	√	
Mirnov coils – 3-axis proto.		

Note special diagnostic requirements in Sec. 4

Diagnostic	Need	Want
MSE	√	
NPA – E‖B scanning		
NPA – solid state		
Neutron measurements	√	
Plasma TV		
Reciprocating probe		
Reflectometer – 65GHz	√	
Reflectometer – correlation	√	
Reflectometer – FM/CW	√	
Reflectometer – fixed f	√	
Reflectometer – SOL		
RF edge probes		
Spectrometer – SPRED		
Spectrometer – VIPS		
SWIFT – 2D flow		
Thomson scattering	√	
Ultrasoft X-ray arrays	√	
Ultrasoft X-rays – bicolor		
Ultrasoft X-rays – TG spectr.		
Visible bremsstrahlung det.		
X-ray crystal spectrom. - H		
X-ray crystal spectrom. - V		
X-ray fast pinhole camera		
X-ray spectrometer - XEUS		